

We claim:

1. A renal replacement therapy system, comprising:

a fluid circuit and blood treatment device in which an ingoing fluid is supplied, and an outgoing fluid is generated, in relation to a treatment process of said blood treatment device;

the blood treatment engaging said fluid circuit to effect first and second cycles of operation where the fluid circuit has at least one chamber that displaces the outgoing fluid with the ingoing fluid during the first cycle and displace the ingoing fluid with the outgoing going fluid during the second cycle, the outgoing fluid being disposed of during said first and second cycles such that said ingoing and outgoing fluids remain in substantial balance;

the blood treatment device effecting a third cycle in which it recirculates the outgoing fluid rather than disposing of it such that said ingoing fluid is displaced and thereby supplied to said blood treatment process without a corresponding quantity of outgoing fluid being generated thereby.

2. A system as in claim 1, wherein said third cycle includes fourth cycle in which said recirculated outgoing fluid is displaced with the ingoing fluid during the first cycle and a fifth cycle in which the ingoing fluid is displaced with the recirculated outgoing fluid.

3. A system as in claim 1, wherein said blood treatment device effects a fourth cycle in at least some of said outgoing fluid bypasses said at least one chamber to reduce a quantity of said ingoing fluid displaced by it such that said ingoing and outgoing fluids are substantially unbalanced during said fourth cycle.

4. A renal replacement therapy system, comprising:

a fluid circuit and blood treatment device in which an ingoing fluid is supplied, and an outgoing fluid is generated, in relation to a treatment process of said blood treatment device;

the blood treatment engaging said fluid circuit to effect first and second cycles of operation where the fluid circuit has at least one chamber that displaces the outgoing fluid with the ingoing fluid during the first cycle and displace the ingoing fluid with the outgoing going fluid during the second cycle, the outgoing fluid being disposed of during said first and second cycles such that said ingoing and outgoing fluids remain in substantial balance;

the blood treatment device effecting a third cycle in which at least a portion of said outgoing fluid is circulated back is recirculated to shift said substantial balance is tilted in favor of said ingoing fluid, a result of said shift being to cause additional fluid to be infused into a patient being subjected to said treatment process.

5. A system as in claim 4, wherein blood treatment device effects a fourth cycle in which at least some of said outgoing fluid bypasses said at least one chamber causing said ingoing and outgoing fluids to be out of balance in favor of said outgoing fluid during said fourth cycle.

6. A fluid replacement system, comprising:

blood treatment apparatus that generates outgoing fluid and consumes ingoing fluid;

a chamber including an interior wall dividing the chamber into a first compartment to retain a volume of outgoing fluid and a second compartment to retain a volume of ingoing fluid, the interior wall responding to differential fluid pressure to displace outgoing fluid from the first compartment as ingoing fluid is conveyed into the second compartment and vice versa,

an outgoing line to conduct outgoing fluid,
a first pump assembly communicating with the outgoing line and the first compartment,
a second pump assembly communicating with a source of ingoing fluid and the second compartment,
a third pump assembly communicating with the outgoing line and the first compartment in at a location upstream of the first pump assembly, and
a controller coupled to the first, second, and third pump assemblies, being operable in a first cycle, during which the first and second pump assemblies are operated to convey a volume of outgoing fluid into the first compartment to displace a volume of ingoing fluid from the second compartment, the controller also being operable in a second cycle, during which the first and second pump assemblies are operated to convey a volume of ingoing fluid into the second compartment to displace a volume of outgoing fluid from the first compartment, the controller being selectively operable during the first and second cycles to operate the third pump assembly in a bolus mode, during which a volume of outgoing fluid is recirculated from the first compartment into the outgoing line to displace ingoing fluid from the second compartment while limiting removal of additional outgoing fluid by the blood treatment apparatus.

7. A system according to claim 6, wherein the controller is selectively operable to operate the third pump assembly in an ultrafiltration mode, during which outgoing fluid is conveyed from the outgoing line in a path that bypasses the first pump assembly.

8. A system according to claim 7, wherein the controller is operable in the ultrafiltration mode during the first and second cycles.

9. A system according to claim 6, wherein the controller operates during the first and second cycles to achieve a predetermined volumetric balance between waste fluid conveyed into the first compartment and replacement fluid conveyed from the second compartment, and vice versa.

10. A system according to claim 6, wherein the controller is operable to maintain prescribed pump rates for the first, second, and third pump assemblies, and

wherein, during the bolus mode, the pump rate prescribed for the third pump assembly is less than the pump rate prescribed for either the first pump assembly or the second pump assembly.

11. A fluid replacement system for use with a blood treatment process, comprising:

a balancing mechanism with a first pumping portion to eject an outgoing fluid received from a blood processing component;

a controller and a flow circuit permitting outgoing fluid ejected thereby to be selectively conveyed either to a outgoing receiver or recirculated back to said first pumping portion;

said balancing mechanism also having a second pumping portion receiving and ejecting ingoing fluid, a rate of said ejecting ingoing fluid being appropriate for infusion into a patient during a blood treatment;

said first and second pumping portions being mechanically interconnected such that outgoing fluid received by said first pumping portion displaces ingoing fluid in said second pumping portion, thereby determining a rate at which said ingoing fluid is ejected from said second pumping section;

said controller being configured to recirculate said outgoing fluid at at least one point during a treatment, in response to a command to provide extra ingoing fluid to said patient.

12. A system as in claim 10, wherein said blood treatment process includes hemofiltration.

13. A fluid replacement system for use with a blood treatment process, comprising:
 a balancing mechanism with a first pumping portion connectable to a blood treatment portion and operable to receive and eject outgoing fluid therefrom;
 a controller and a flow circuit permitting outgoing fluid ejected thereby to be selectively conveyed either to a outgoing receiver or recirculated back to said first pumping portion;
 said balancing mechanism also having a second pumping portion receiving and ejecting ingoing fluid;
 said first and second pumping portions being mechanically interconnected such that outgoing fluid received by said first pumping portion displaces ingoing fluid in said second pumping portion, thereby determining a rate at which said ingoing fluid is ejected from said second pumping section;

said controller being configured to recirculate said outgoing fluid at at least one point during a treatment, in response to a command to provide extra ingoing fluid to said patient;

wherein said first and second pumping portions each include at least one flexible chamber, said first pumping portion flexible chamber pressing against said second pumping portion flexible chamber when said first pumping portion flexible chamber fills with outgoing.

14. A fluid replacement system for use with a blood treatment process, comprising:
a blood treatment device generating outgoing fluid and consuming ingoing fluid;
a balancing mechanism configured such that said outgoing fluid displaces said ingoing fluid at a volume rate equal to a rate at which said outgoing fluid is received by said balancing mechanism;

a flow circuit being configured to convey outgoing fluid ejected from said balancing mechanism to be selectively conveyed to at least one of said outgoing inlet and a outgoing receiver responsively to a controller;

said controller being configured to convey at said some of said outgoing fluid to said outgoing inlet, in response to a command to provide a volume of ingoing fluid, whereby said at least some of said outgoing fluid may displace said ingoing fluid in said balancing mechanism without a corresponding amount of outgoing fluid being received by said balancing mechanism.

15. A system as in claim 14, wherein said blood treatment process includes hemofiltration.

16. A system as in claim 14, wherein said blood treatment device includes a hemofilter.

17. A system as in claim 14, wherein said positive displacement balancing mechanism includes at least two flexible chambers, a first of which receives outgoing, a second of which receives ingoing fluid, said positive displacement balancing mechanism being configured such that said first flexible chamber presses against said second flexible chamber to displace said ingoing fluid in proportion to an amount of outgoing fluid received thereat.